Coastal Engineering Technical Note

DESIGN OF RUBBLE FOUNDATION AND RUBBLE TOE PROTECTION

PURPOSE: To make basic design guidance found on pages 7-243 and 7-244 of SPM for design of rubble foundation for composite breakwater and rubble toe protection for vertical wall breakwater and bulkhead conform to recent changes to design guidance. This method provides a more conservative design than that presented in the SPM and is recommended for nonbreaking wave designs for both toe protection for vertical wall breakwaters and bulkhead and foundations for composite breakwaters as illustrated in Figure 1.

INTRODUCTION: As a result of laboratory tests on irregular waves, a design method Tanimoto, (1982) has been developed for calculating the stability number for rubble foundations and toe protection. Figure 7-120 of the SPM should be replaced with Figure 2.

Figure 1.

The design stability number, N_S, is calculated as follows:

$$N_S = 1.8$$

or

$$N_S = \left[1.3 \frac{1-\kappa}{\kappa^{1/3}} \frac{d_1}{H} + 1.8 \exp. \left(-1.5 \frac{(1-\kappa)^2}{\kappa^{1/3}} \frac{d_1}{H}\right)\right]$$

whichever value proves to be larger.

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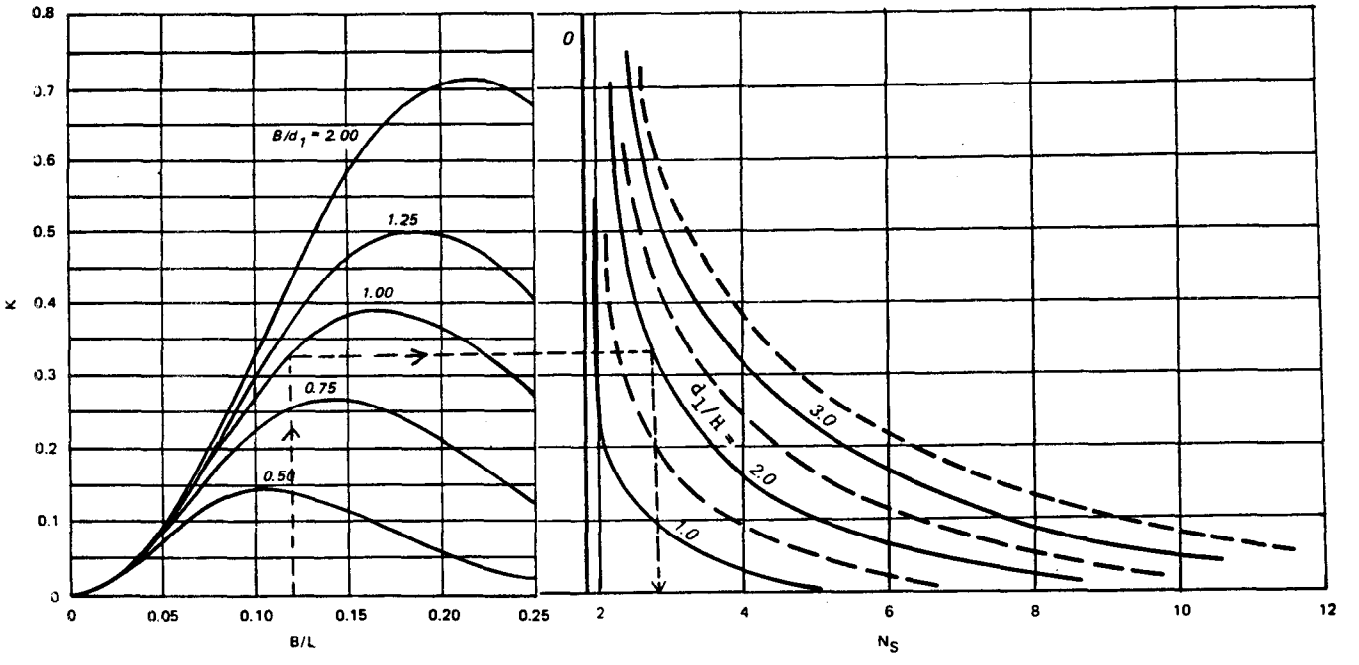

Figure 2.

where:

K = parameter representing the combined effects of the relative water depth and the relative distance from the vertical wall on the maximum horizontal velocity at the bottom.

H = design wave height associated with depth d_s

L = wavelength associated with the depth d_1

d_s = depth at structure

B = toe apron width

SAMPLE PROBLEM: A vertical wall breakwater is sited in Lake Michigan with the specific gravity of the rock, S_r = 2.60, the unit weight of rock, W_r = 25,400 N/cu m (162 lb/cu ft), d_s = 3.0 m (10 ft), d_1 = 1.8 m (6 ft), and L = 15.5 m (51 ft). The design wave height, H, associated with the water depth at the site of the structure was estimated to be 0.9 m (3 ft) using the procedure found in the SPM and the toe apron width B = 1.8 m (6 ft). FIND: Toe stone weight, W.

SOLUTION: B/d_1 = 1.00 and B/L = 0.12. K from Figure 2 is estimated to be 0.33. N_s = 2.80. From equation 7-125 in SPM,

$$W = \frac{W_r H^3}{N_s^3 (S_r - 1)^3} = \frac{(25,400)(0.9^3)}{(2.80^3)(2.60-1)^3} = 206 N (46 lb)$$

ADDITIONAL INFORMATION: Questions can be directed to Mr. Gordon E. Staab at (601) 634-2139, of the Coastal Design Branch at CERC.

REFERENCES:

"Design of Coastal Revetments, Seawalls, and Bulkheads," EM 1110-2-1614, 1985. Office of the Chief of Engineers, Washington, DC.

Shore Protection Manual. 1984. 4th ed., 2 vols, US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, US Government Printing Office, Washington, DC.

Tanimoto, K., Yagyu, Y., and Goda, Y. 1982. "Irregular Wave Tests for Composite Breakwater Foundations." Proceedings of the Eighteenth Coastal Engineering Conference, Vol. III.